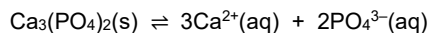


Suggested Answers to Self-Check Questions

- 1 (a) Refer to IVY Solubility Equilibria Check Point 1 (Question 1) for worked solution. $K_{sp} = 1.77 \times 10^{-14} \text{ mol}^4 \text{ dm}^{-12}$.
 (b) Refer to IVY Solubility Equilibria Check Point 1 (Question 2) for worked solution. Solubility = 0.0729 g dm^{-3} .
 (c) Let the solubility of $\text{Ca}_3(\text{PO}_4)_2$ in water be $s \text{ mol dm}^{-3}$.



At equilibrium in the saturated solution, $[\text{Ca}^{2+}] = 3s \text{ mol dm}^{-3}$

$$[\text{PO}_4^{3-}] = 2s \text{ mol dm}^{-3}$$

$$K_{sp} \text{ of } \text{Ca}_3(\text{PO}_4)_2 = [\text{Ca}^{2+}]^3 [\text{PO}_4^{3-}]^2 = (3s)^3 (2s)^2 = 1.0 \times 10^{-26} \text{ mol}^5 \text{ dm}^{-15}$$

$$108s^5 = 1.0 \times 10^{-26}$$

$$s = \left(\frac{1.0 \times 10^{-26}}{108} \right)^{1/5} = 2.474 \times 10^{-6} \text{ mol dm}^{-3}$$

Hence $[\text{Ca}^{2+}]$ in the saturated solution = $(3)(2.474 \times 10^{-6}) = 7.42 \times 10^{-6} \text{ mol dm}^{-3}$

- 2 Refer to IVY Solubility Equilibria Check Point 2 for explanation. Since ionic product $< K_{sp}$, precipitation of LiF will not occur.

- 3 (a) Upon mixing the two solutions and assuming no reaction,

$$[\text{Ca}^{2+}] = \left(\frac{2}{1000} \times 0.50 \right) \div \frac{2+1}{1000} = 0.3333 \text{ mol dm}^{-3}$$

$$[\text{NaOH}] = [\text{OH}^-] = \left(\frac{1}{1000} \times 2.0 \right) \div \frac{2+1}{1000} = 0.6667 \text{ mol dm}^{-3}$$

$$\text{Ionic product} = [\text{Ca}^{2+}][\text{OH}^-]^2 = (0.3333)(0.6667)^2 = 0.148 \text{ mol}^3 \text{ dm}^{-9}$$

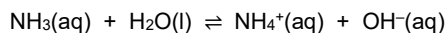
Since ionic product $> K_{sp}$ of $\text{Ca}(\text{OH})_2$, precipitation of $\text{Ca}(\text{OH})_2$ will occur.

A white precipitate will be observed in the test-tube.

- (b) Upon mixing the two solutions and assuming no reaction,

$$[\text{Ca}^{2+}] = \left(\frac{2}{1000} \times 0.50 \right) \div \frac{2+1}{1000} = 0.3333 \text{ mol dm}^{-3}$$

$$[\text{NH}_3] = \left(\frac{1}{1000} \times 2.0 \right) \div \frac{2+1}{1000} = 0.6667 \text{ mol dm}^{-3}$$



At equilibrium, $[\text{NH}_4^+] = [\text{OH}^-]$

$[\text{NH}_3]_{\text{eqm}} \approx [\text{NH}_3]_{\text{initial}} = 0.6667 \text{ mol dm}^{-3}$, since NH_3 is a weak base with a small K_b ,

$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = \frac{[\text{OH}^-]^2}{[\text{NH}_3]}$$

$$[\text{OH}^-] = \sqrt{(1.74 \times 10^{-5})(0.6667)} = 3.406 \times 10^{-3} \text{ mol dm}^{-3}$$

$$\text{Ionic product} = [\text{Ca}^{2+}][\text{OH}^-]^2 = (0.3333)(3.406 \times 10^{-3})^2 = 3.87 \times 10^{-6} \text{ mol}^3 \text{ dm}^{-9}$$

Since ionic product $< K_{sp}$ of $\text{Ca}(\text{OH})_2$, precipitation of $\text{Ca}(\text{OH})_2$ will not occur.

No white precipitate will be observed in the test-tube.